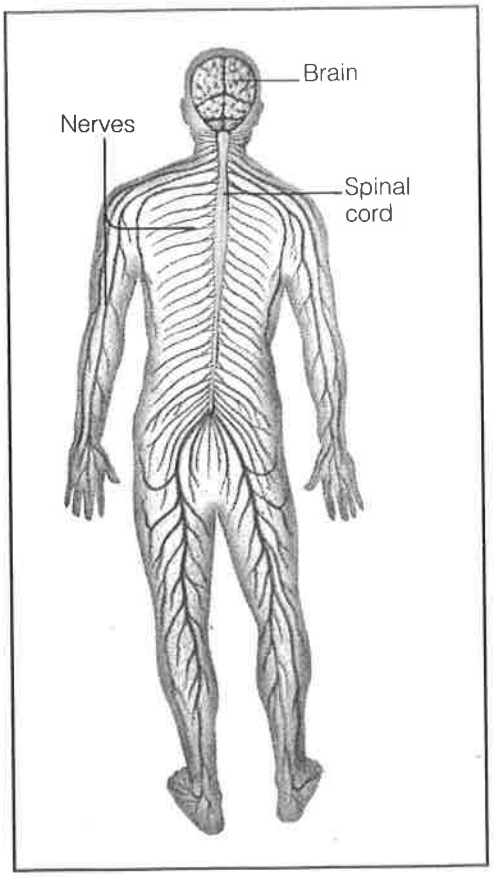
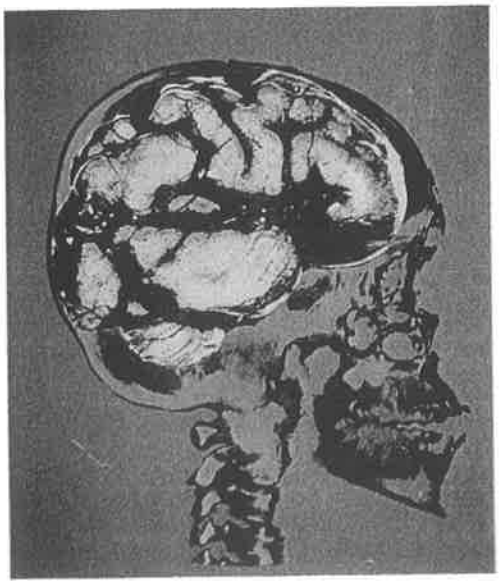


Figure 6–7 *The human nervous system is made up of the central nervous system and the peripheral nervous system. The central nervous system contains the brain and the spinal cord. The peripheral nervous system contains all the nerves that branch out from the central nervous system.*



system. The human nervous system is divided into two parts: the central nervous system and the peripheral nervous system.

All information about what is happening in the world inside or outside your body is brought to the central nervous system. **The central nervous system, which contains the brain and the spinal cord, is the control center of the body.**

The other part of the human nervous system is the peripheral (puh-RIHF-uh-ruhl) nervous system. **The peripheral nervous system consists of a network of nerves that branch out from the central nervous system and connect it to the organs of the body.** Put another way, the peripheral nervous system is made up of all the nerves that are found outside the central nervous system. In fact, the word peripheral means outer part.

The Central Nervous System

If you were asked to write a list of your ten favorite rock stars and at the same time name all fifty states aloud, you would probably say you were being asked to do the impossible. And you would be quite correct. It is obvious that the nervous system is not able to control certain functions at the same time it is busy controlling other functions. What is less obvious, however, is just how many functions the brain can control at one time! For example, even an action as simple as sitting quietly in a movie theater requires several mental operations.

Many kinds of impulses travel between your central nervous system and other parts of your body as you watch a movie. Some nerve impulses control the focus of your eyes and the amount of light that enters them. Other nerve impulses control your understanding of what you see and hear. At the same time, still other nerve impulses regulate a variety of body activities such as breathing and blood circulation. And all these impulses may be related to one another. For example, if you are frightened by a scene in the movie, your breathing and heart rates

Figure 6–8 *This photograph is actually a combination of two photographs. One is an X-ray of a human skull. The other is of a human brain that has been properly positioned over the X-ray. What is the function of the skull?*

will likely increase. If, on the other hand, you are bored, these rates may decrease. In fact, you might even fall asleep!

The activities that occur within the central nervous system are very complex. Interpreting the information that pours in from all parts of your body and issuing the appropriate commands to these very same parts are the responsibility of the two parts of the central nervous system: the **brain** and the **spinal cord.** The brain is the main control center of the central nervous system. It transmits and receives messages through the spinal cord. The spinal cord provides the link between the brain and the rest of the body.

THE BRAIN If you are a fan of the English author Agatha Christie, you may remember the words uttered by her fictional detective Hercule Poirot as he attempted to solve a mystery: "These little gray cells! It is up to them." Indeed, much of the human brain does appear to be gray as a result of the presence of the cell bodies of billions of neurons. Underneath the gray material is white material, which is made of bundles of axons.

Despite the presence of billions of neurons, the mass of the brain is only about 1.4 kilograms. As you might expect of such an important organ, the brain is very well protected. A bony covering called the skull encases the brain. (You may recall from Chapter 2 that the skull is part of the skeletal system.) The brain is also wrapped by three layers of connective tissue, which nourish and protect it. The inner layer clings to the surface of the brain and follows its many folds. Between the inner layer and the middle layer is a watery fluid. The brain is bathed in this fluid and is thus cushioned against sudden impact, such as when you bump heads with another person while playing soccer or when you take a nasty fall. The outer layer, which makes contact with the inside of the bony skull, is thicker and tougher than the other two layers.

Looking like an oversized walnut without a shell, the **cerebrum** (SER-uh-bruhm) is the largest and most noticeable part of the brain. As you can see from Figure 6–11 on page 140, the cerebrum is lined with deep, wrinkled grooves. These grooves greatly increase the surface area of the cerebrum, thus allowing more

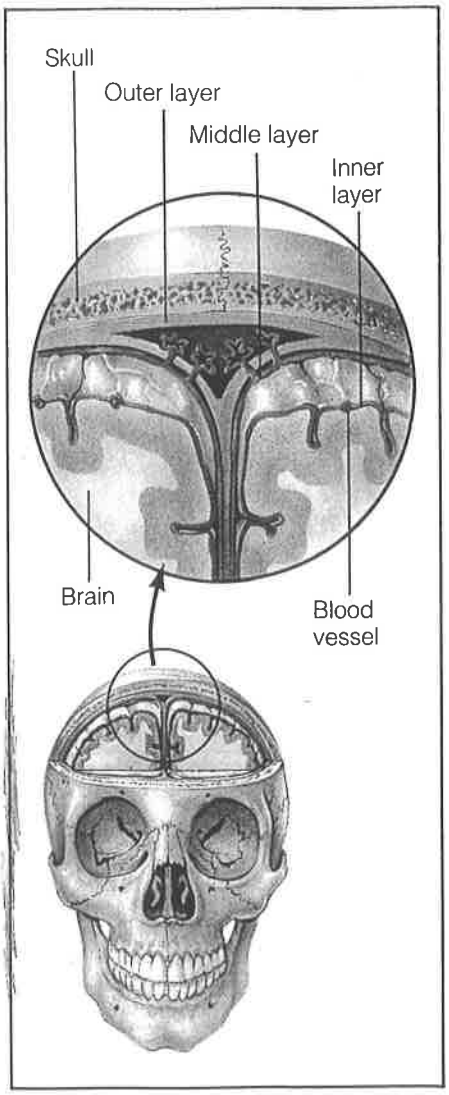


Figure 6–9 *The brain is wrapped by three layers of connective tissue, which nourish and protect it. Covering the brain and its three layers of connective tissue is a bony skull.*

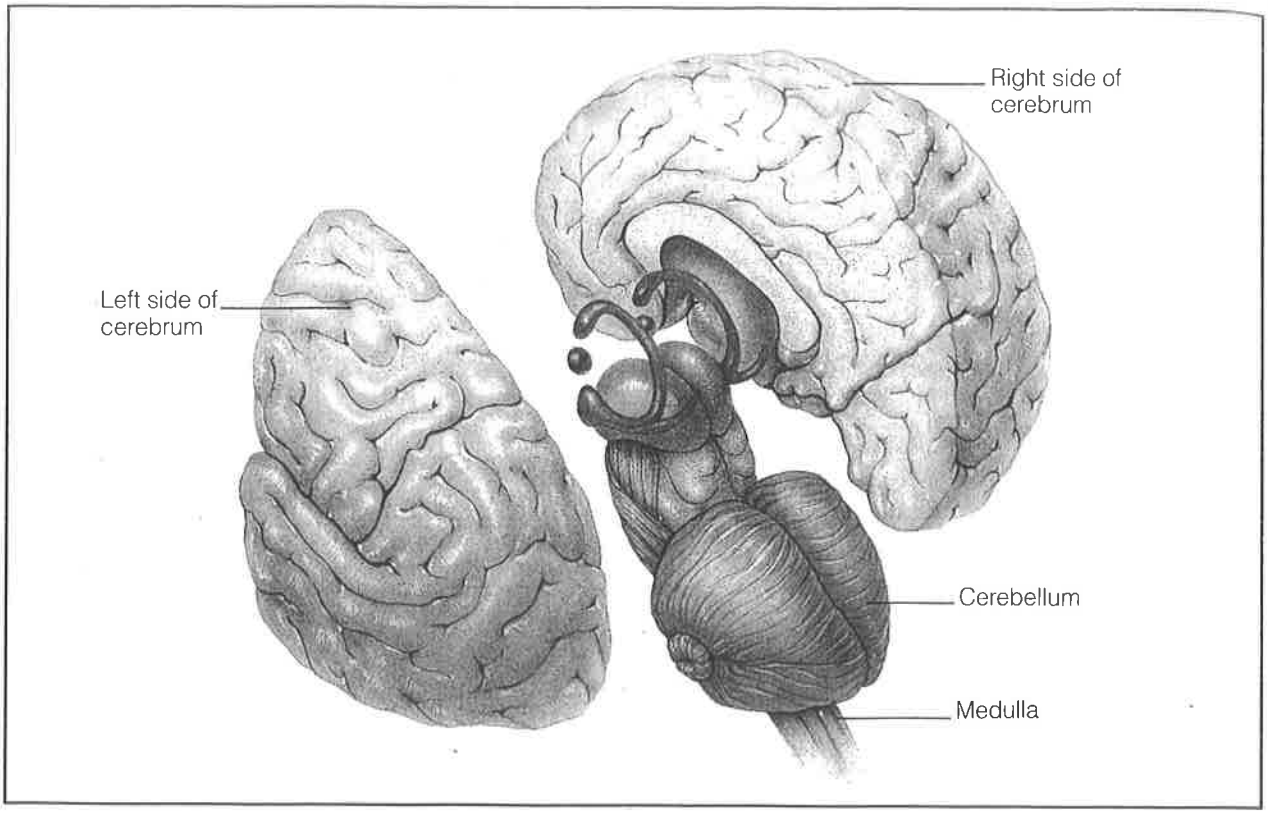
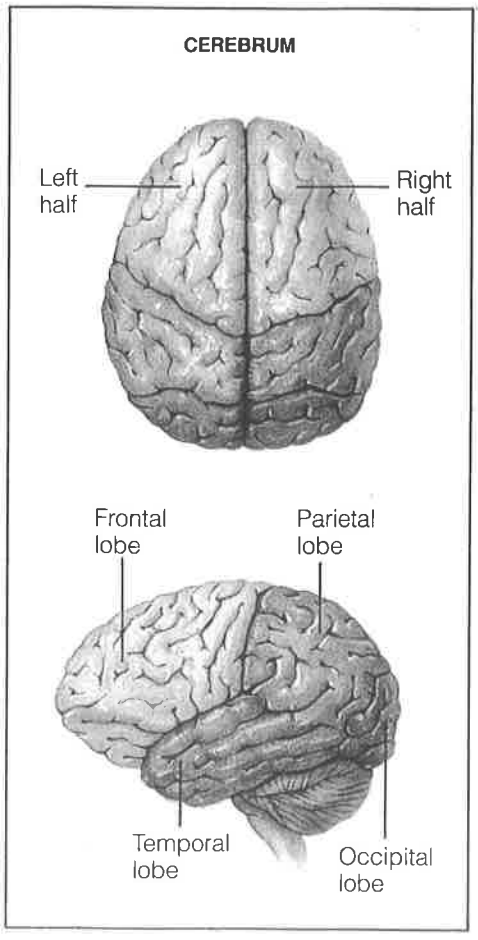


Figure 6–10 *The human brain consists of the cerebrum, cerebellum, and medulla. What is the function of each part?*



activities to occur there. You can appreciate how important this feature is when you consider that the cerebrum is the area where learning, intelligence, and judgment occur. Increased surface area means increased thinking ability. But this is not all the cerebrum does. It also controls all the voluntary (under your control) activities of the body. In addition, it shapes your attitudes, your emotions, and even your personality.

Another interesting feature of the cerebrum (which you may have noticed in Figure 6–11) is that it is divided into halves: a right half and a left half. Each half controls different kinds of mental activity. For example, the right half is associated with artistic ability and the left half is associated with mathematical ability. And each half controls the movement of and sends sensations to the side of the body opposite it. In other words, the right side of the brain

Figure 6–11 *The cerebrum is divided into two halves. Each half contains four lobes, or sections. What are the names of these lobes?*

controls the left side of the body; the left side of the brain controls the right side of the body.

Below and to the rear of the cerebrum is the **cerebellum** (ser-uh-BEHL-uhm), the second largest part of the brain. The cerebellum's job is to coordinate the actions of the muscles and to maintain balance. As a result, your body is able to move smoothly and skillfully.

Below the cerebellum is the **medulla** (mih-DUHL-uh), which connects the brain to the spinal cord. The medulla controls involuntary actions, such as heartbeat, breathing, and blood pressure. Can you name some other types of involuntary actions?

SPINAL CORD If you bend forward slightly and run your thumb down the center of your back, you can feel the vertebrae that make up your spinal column. As you may recall from Chapter 2, the vertebrae are a series of bones that protect the spinal cord. The spinal cord runs the entire length of the neck and back. It connects the brain with the rest of the nervous system through a series of 31 pairs of

Figure 6–12 *Impulses are constantly traveling across neurons such as these located in the brain. To what part of the human nervous system does the brain belong?*

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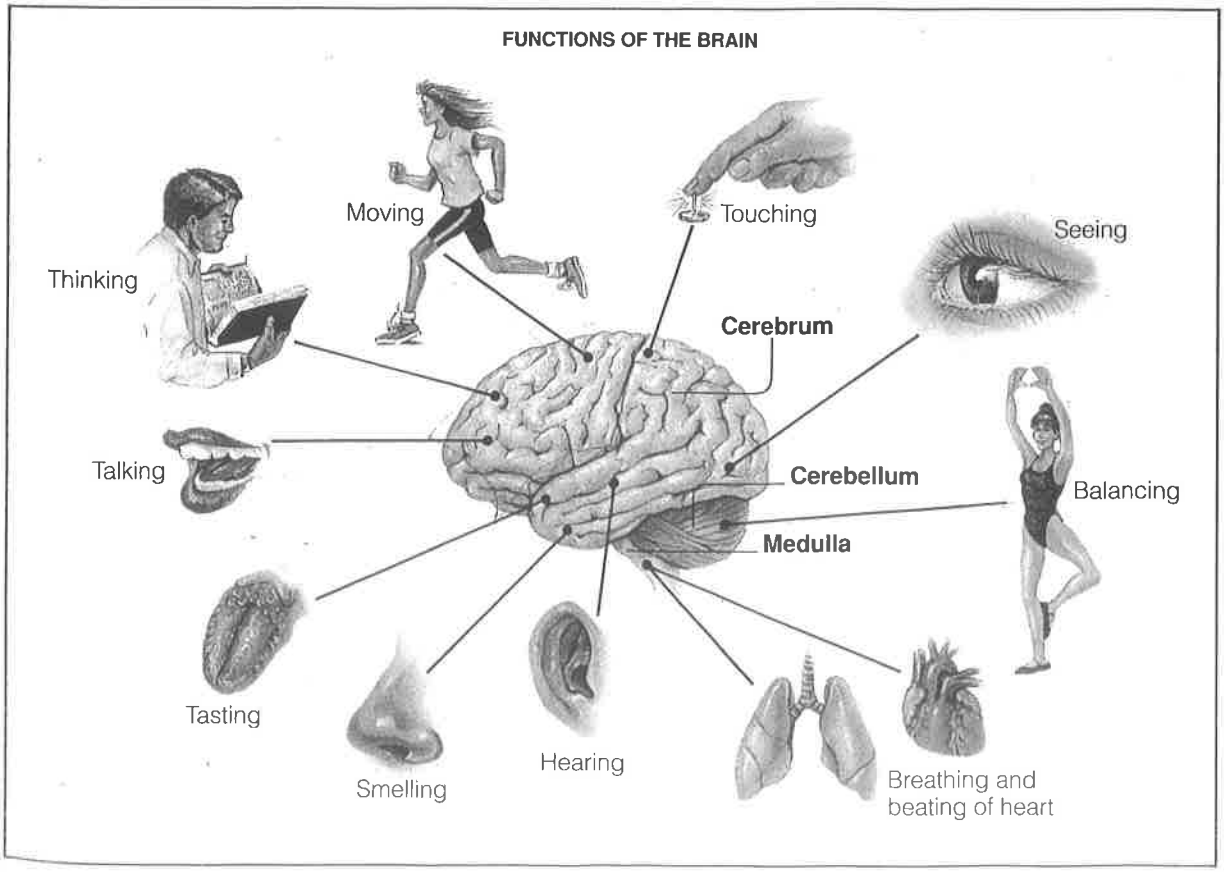
How Fast Can You React?, p. 255

Figure 6–13 *The brain directs and coordinates all the body's activities. What is the function of the cerebellum?*



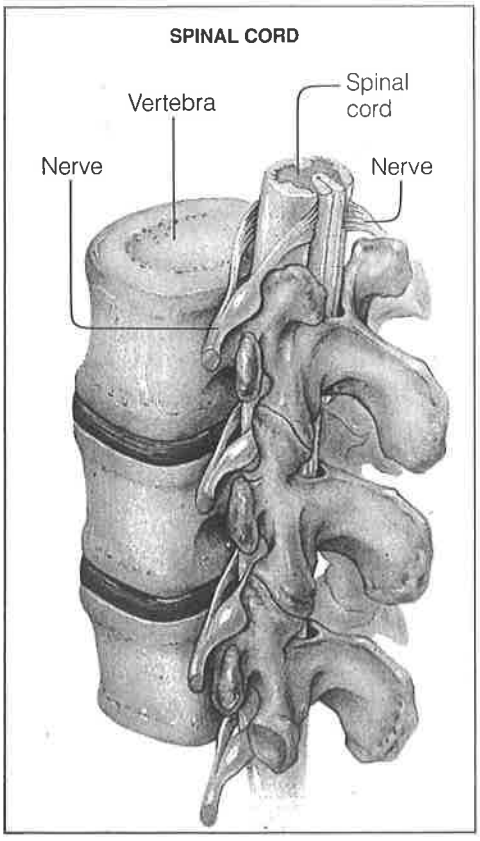


Figure 6–14 *The spinal cord, which provides the link between the brain and the rest of the body, is about 43 centimeters long and as flexible as a rubber hose. As the diagram shows, the spinal cord is protected by a series of bones called vertebrae that make up the vertebral column.*

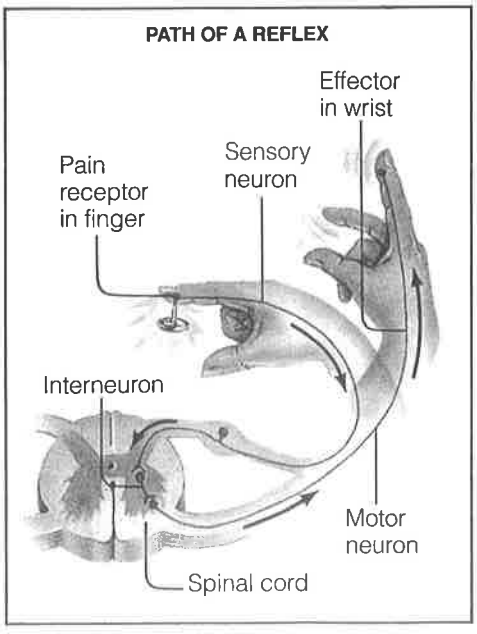
nerves. These nerves carry nerve impulses to and from the spinal cord.

Quite possibly, you are so interested in reading this chapter that you do not notice a fly circling in the air above your head. But if the fly happens to come close to your eyes, your eyes will automatically blink shut. Why?

A simple response to a stimulus (fly coming near your eyes) is called a **reflex.** In this example, the reflex begins as soon as the fly approaches your eyes. The fly's action sends a nerve impulse through the sensory neurons to the spinal cord. In the spinal cord, the nerve impulse is relayed to interneurons, which send the nerve impulse to motor neurons. The motor neurons stimulate the muscles (effectors) of the eyes, causing them to contract and so you blink.

Reflexes are not only lightning-fast reactions, they are also automatic. Their speed and automatic nature are possible because the nerve impulses travel only to the spinal cord, bypassing the brain. The brain does become aware of the event, however, but only after it has happened. So the instant after you

Figure 6–15 *If you touch a thumbtack, you will pull your finger away from it quickly. This reaction is an example of a reflex.*



blink, your brain knows that you blinked and why you blinked.

The Peripheral Nervous System

The peripheral nervous system is the link between the central nervous system (brain and spinal cord) and the rest of the body. The peripheral nervous system consists of pairs of nerves (43 to be exact) that arise from the brain and spinal cord and lead to organs throughout your body. Many of the nerves in the peripheral nervous system are under the direct control of your conscious mind. For example, when you "tell" your leg to move, a message travels from your brain to your spinal cord and through a peripheral nerve to your leg. There is one part of the peripheral nervous system, however, that is not under the direct control of your conscious mind. This part, called the autonomic (awt-uh-NAHM-ihk) nervous system, controls body activities that are involuntary—that is, body activities that happen automatically without your thinking about them. For example, contractions of the heart muscle and movement of smooth muscles surrounding the blood vessels and the organs of the digestive system are activities under the control of the autonomic nervous system.

The nerves of the autonomic nervous system can be divided into two groups that have opposite effects on the organs they control. One group of nerves triggers an action by an organ while the other group of nerves slows down or stops the action. Thus, the nerves of the autonomic nervous system work against each other to keep body activities in perfect balance.

ACTIVITY DISCOVERING

Fight or Flight?

1. Working with a partner, determine your pulse rate (heartbeats per minute) and breathing rate (breaths per minute) while you are at rest. Record your data.

2. Now do ten jumping jacks. **CAUTION:** *If you have any respiratory illnesses, do not perform steps 2 and 3.*

3. After exercising, measure your pulse rate and breathing rate. Your partner can measure your pulse while you are counting your breaths. Record this "after exercise" data.

Describe any changes in pulse rate and breathing rate after exercising.

■ How do these changes compare with those that occur when you are faced with an emergency situation? What other body changes occur when you react to an emergency?

Part of Body Affected	Autonomic Nervous System Nerve Group That Triggers Action	Autonomic Nervous System Nerve Group That Slows Down Action
Pupil of eye	Widened	Narrowed
Liver	Sugar released	None
Urinary bladder muscle	Relaxed	Shortened
Muscle of heart	Increased rate and force	Slowed rate
Bronchi of lungs	Widened	Narrowed

Figure 6–16 *The nerves of the autonomic nervous system can be divided into two groups that have opposite effects on the organs they control.*

ACTIVITY READING

A Master Sleuth

If you truly enjoy a mystery, you may want to do some investigating on your own by reading some of Agatha Christie's books. The title of the book that was quoted on page 139 is *The Mysterious Affair at Styles*. If your local library does not have this particular work, ask your librarian for a list of some other Agatha Christie books.

For example, when you are frightened, nerves leading to organs such as the lungs and the heart are activated. This action causes your breathing rate and heartbeat to increase. Such an increase may be necessary if extra energy and strength are needed to deal with the frightening situation. But when the frightening situation is over, the other group of autonomic nerves bring your breathing rate and heartbeat back to normal.

6–2 Section Review

1. What are the two major parts of the human nervous system? What is the function of each?
2. Identify the three main parts of the brain and give their functions.
3. What is the function of the spinal cord?
4. Describe a reflex.

Critical Thinking—*Applying Concepts*

5. If a person's cerebellum is injured in an automobile accident, how might the person be affected?

Guide for Reading

Focus on these questions as you read.

- *What are the five sense organs?*
- *What are the functions of the five sense organs?*

6–3 The Senses

You know what is going on inside your body and in the world around you because of neurons known as receptors (neurons that respond to stimuli). Many of these receptors are found in your sense organs. Sense organs are structures that carry messages about your surroundings to the central nervous system. **Sense organs respond to light, sound, heat, pressure, and chemicals and also detect changes in the position of your body.** The eyes, ears, nose, tongue, and skin are examples of sense organs.

Most sense organs respond to stimuli from your body's external environment. Others keep track of the environment inside your body. Although you are not aware of it, your sense organs send messages to the central nervous system about almost everything—from body temperature to carbon dioxide and oxygen levels in your blood to the amount of light entering your eyes.

Activity Bank

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